COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

March, 1943

Courtesy of Hydraulic Press Mfg. Co.

This 300-ton hydraulic press plays an important part in the War Program in turning out thousands of boiler hand-hole covers for Liberty Ships

Reduction of Induced-Draft Fan Erosion ▶

Coal-Handling Installation for New Plant Extension ▶

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VOLUME FOURTEEN NUMBER NINE

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FOR MARCH 1943

FEATURE ARTICLES

EDITORIALS

DEPARTMENTS

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EDITORIAL

Scrap Still Needed

The nationwide drive for scrap late in 1942 met with a splendid response from all quarters. There resulted a vast quantity of light scrap; but heavy scrap, although large, was insufficient to meet all the requirements. The huge scrap piles that have been visible in many places should not lead to the impression that the task has been completed; for they soon will be used up in meeting the increased production schedules of the current year. The second half of 1943 will require a large additional tonnage to carry on.

There is necessarily a considerable time lag involved in the collection, sorting and distribution of scrap, which makes it imperative that there be no slackening in the effort. This applies particularly to heavy industrial scrap upon which the steel industry must place its main reliance. The situation is being emphasized by the WPB Resources Division which has enlisted the assistance of the industrial press in stressing the need.

To date, the initial response from utilities in providing scrap of all kinds has been outstanding, but their subsequent contributions will necessarily be smaller. This applies also to many industrial plants, although it is believed that others still provide an additional reservoir. Of course, anything that has an assured or potential use in meeting the war effort in its present form, or that may be repaired and rendered usable, should be conserved, as it will avoid the purchase of new equipment. However, as time goes on the need for obsolete or extra reserve equipment will become clarified and simplify a decision as to its retention.

Authoritative tax opinion has held that the *undepreciated* cost of any equipment that is donated to salvage is deductible for tax income purposes in the year in which such donation takes place.

The situation at present calls for the setting up of continuous salvage programs by all establishments that may be in a position to contribute heavy scrap, for only by such means will the need be met as the present scrap piles become depleted.

Substitute Materials

Necessity, born of war conditions, has ever been productive of accelerated progress along mechanical, metallurgical and chemical lines. Especially does this apply to the present conflict in which unprecedented demands for certain materials and interrupted supply of others have changed assumed abundance into acute shortage, making necessary the employment of numerous substitutes.

Despite research and progress in normal times, there has always been some reluctance among engineers to depart from long-accepted practice in the employment of well-proved materials. Now, however, faced with mandates from the War Production Board governing the use of many materials, industry has been put to the test of finding suitable substitutes. This has brought about a number of emergency standards and revised specifications, some of which are likely to become permanent as performance demonstrates their adequacy.

Moreover, the post-war period is certain to make more extensive use of those materials, the productive capacity of which has been greatly expanded to meet wartime needs and which will therefore be plentiful at costs well under those previously prevailing. Also, the fact that many industrial plants will require extensive reconversion to fit them for peacetime manufacture will open the way for employment of new practices and materials.

While the effect will be far-reaching and extend to many lines of industry, it is also likely to leave its mark on the power-plant field, some indications of which are already apparent in such items as new bearing alloys, substitutes for brass and copper in instruments, for steel in panel boards and for rubber in insulation, as well as lowered factors of safety to reduce material requirements. Many others could be cited. The longer the period of the emergency, the greater will be the number of such applications. Although the effect on basic power plant design may be small, that on certain component parts may be considerable.

To Discuss War-Time Power Problems

In deference to the request of the Office of Defense Transportation many organizations have cancelled their annual conventions for this year and others have greatly curtailed the scope of regional meetings. By so doing, they are not only assisting in alleviation of the burden on the railroads, but are also avoiding further complication of the hotel situation, particularly in those localities where the armed services have taken over many such accommodations.

While this action is in order for all groups not directly concerned with prosecution of the War, it has been felt that engineering is so directly associated with war production that a limited number of engineering meetings are fully warranted. In fact, they have special significance and usefulness at this time, providing the programs are planned with a view to aiding the war effort.

Falling within this category is the forthcoming Midwest Power Conference in Chicago, April 8–9. It will be devoted largely to a discussion of power problems arising from the War, many of which are now perplexing engineers responsible for maintaining adequate facilities and power supply to meet the abnormal demands. It is believed that all who can attend will be repaid for the time spent.

Reduction of Induced-Draft Fan Erosion

By R. L. LINCOLN, Manager,

Dust Laboratory, B. F. Sturtevant Co.

Under present conditions, the necessity for operating at high ratings and often with coals that are high in ash content, tends to increase the erosion of induced-draft fans. The erosive characteristics of ash with different forms of firing are discussed and suggestions are offered as to measures that will materially reduce such erosion, and divert it to those areas that are readily replaceable instead of the high-speed, heat-treated rotating member which must be maintained in perfect balance.

THE demands of war require that every plant, whether producing process steam or electric power, be maintained at its peak load with minimum outage. This concerns fly-ash erosion of induced-draft fans which is a recognized cause of boiler outage.

Conversion of many plants, previously burning oil, to coal has brought this erosion problem close to many engineers, who, in the past, have had only an academic interest in fly-ash erosion. Other plants, while burning coal in the past, have suddenly discovered that a comparatively small increase in load has caused an unreasonably high increase in fan erosion. A study of the various causes and effects of fly ash may point to a possible solution in reducing fan wear. Many factors which affect the production of fly ash are well known but others are not readily recognized. Some of the present-day causes are given below:

1. The present average load on many plants is now materially higher than even their former peak loads.
2. The ash content of the coal now available is frequently much greater than that of the coal used by the same plant in the past.
3. More coal of higher ash content being burned produces a much greater quantity of ash introduced into the combustion space. The use of more coal and combustion air results in greater velocities in the combustion space and over the heat-absorbing surfaces and through ducts. As a result, the gases carry a higher percentage of the ash without permitting it to settle out as formerly. There is a critical point above which erosion is very rapid.
4. The necessity of using operators who are frequently not as experienced and skilled in operating the particular boiler and fuel as formerly, sometimes leads to excess air further aggravating these conditions.

The presence of some or all of these factors causes a material increase in fly ash today that was not found in pre-war operation. Each different coal feeding system in use produces a characteristic fly ash effecting erosion in a different way.

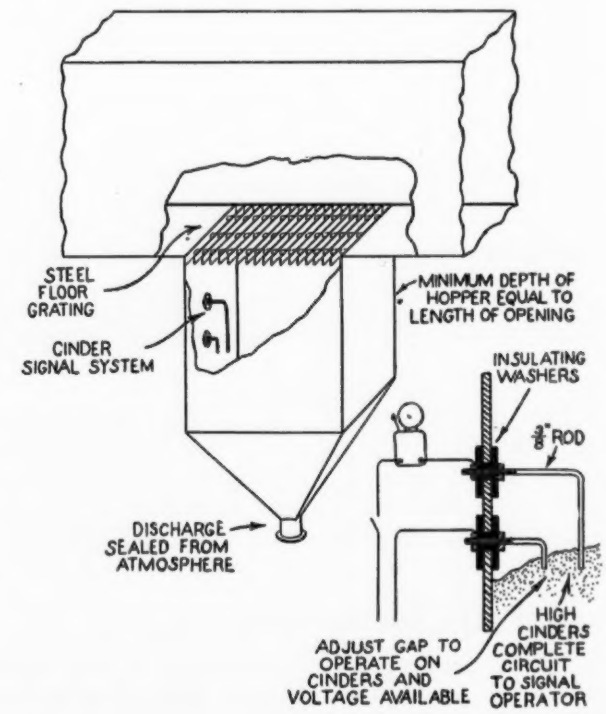

Fig. 1—Recommended form of cinder hopper and signal system detail

PULVERIZED-COAL FIRING, in which the coal is ground very fine and burned in suspension in a region of high temperature, usually produces a fly ash which is almost free of carbon. The ash is frequently fused into minute glass spheres, many of which are broken up and produce a large surface area that is extremely sharp and hard.

Fortunately, however, these particles are extremely small and generally average less than $^1/_{1000}$ in. in diameter. For the same weight of ash and velocity the smaller the ash particle the less the abrasion. Continuous and careful attention to the pulverizer adjustment will pay dividends not only in improved combustion but in reduced abrasion. Often as much as 50 to 75 per cent of the ash in the coal is carried from the furnace with this method of firing.

STOKER-FIRED plants employing stokers of the traveling-grate type are comparatively free of erosion except at high ratings. The coal being burned on the grates has a much greater tendency to fuse into larger agglomerates. Fusion occurs at much lower temperatures and the resulting cinder is large and has a ragged surface. At normal loads this remains on the grate and is removed with the ash. However, if this cinder is carried to the induced-draft fan, rapid erosion is the result and a shower of cinders near the plant may create a problem in factory machine maintenance and in public relations. Maintaining a low combustion rate would help but this is seldom possible under present conditions.

SPREADER STOKERS have a characteristic fly ash which is about halfway between that resulting from pulverized coal and traveling grate stokers. The dust is between the other two in size and usually contains considerable carbon. High ratings produce a high carryover of cinders which can be collected and reintroduced into the furnace for burning. A uniform clean fire without excess forced draft pressure will keep carryover to a minimum.

HAND FIRING is similar to stoker firing in that the fly ash carryover depends upon the rating and the amount of draft. Very careful control of the fuel bed and draft is necessary at higher ratings in order to prevent cinders. Due to the low draft that is usually employed, however, induced-draft-fan erosion is seldom encountered with hand firing at ordinary loads.

FURNACE DESIGN can do much to reduce the amount of fly ash, although the designing engineer is often restricted by other controlling factors that are considered more important. Long gas travel, low gas velocities and high temperatures all tend to reduce carryover. On a recent pulverized-coal-fired wet-bottom furnace a change in baffling reduced the quantity of fly ash by about 30 per cent. The fly ash instead of short-circuiting to the gas outlet was deflected toward the wet bottom of the furnace where most of the larger particles of ash were caught.

DUCT DESIGN is often a neglected source of improvement in obtaining low fly ash discharge and a consequent reduction in fan erosion. Low velocities not only permit the larger cinders to settle out but also, by reducing the duct losses, permit the fan to operate at a lower speed. Hoppers on the bottom of horizontal ducts and at the base of vertical ducts are standard practice. However, their design is usually subject to improvement. A recommended form is shown in Fig. 1. The floor grating, besides making the duct safe for service also reduces eddy currents which frequently sweep cinder hoppers clear, particularly if they are built with shallow depth. The same design of hopper may be used at the base of vertical ducts. This will not replace collectors but will eliminate the very large cinders. Nevertheless, fine abrasive fly ash will still cause trouble unless other measures are taken.

Too infrequent emptying of hoppers is a common condition. One installation of cinder-collecting equipment appeared ineffective as the fans were cut through in five months. Investigation showed no cause for such wear and the operating engineer insisted the hoppers were cleaned out every four hours. Computations indicated this was insufficient and a signal system, similar to that shown, was installed. Subsequent operation showed that the storage hoppers were filling every 45 minutes. With a revised operating schedule to keep

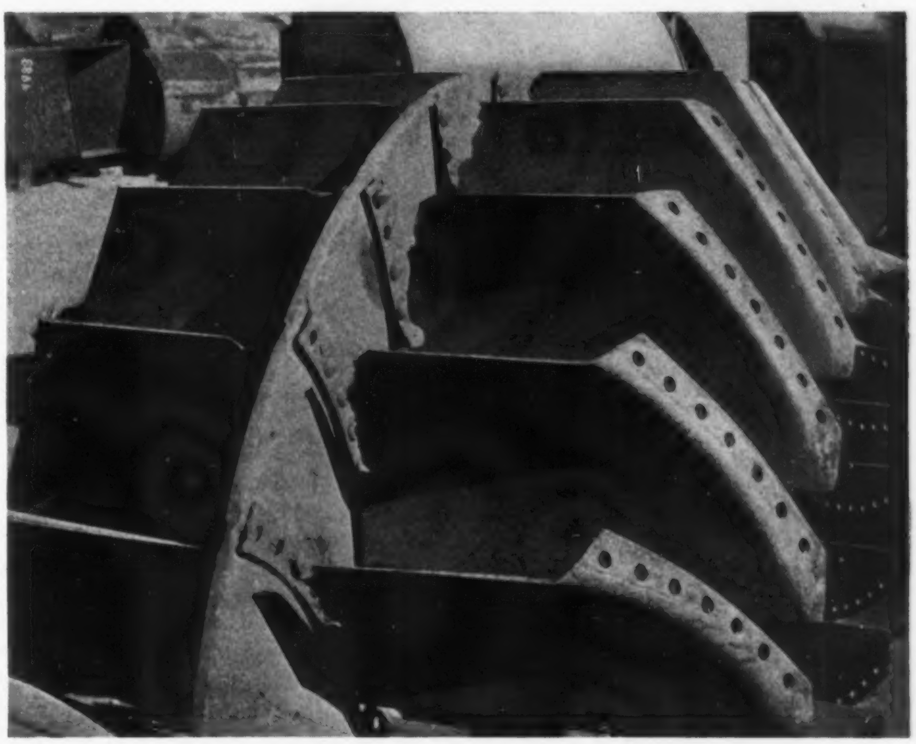

Fig. 2—Example of erosion of induced-draft wheel at center plate

the hopper empty no measurable increase in blade wear has occurred in over two and one-half years of operation. Naturally, the cinder signal system shown will operate only if the cinders contain sufficient carbon to conduct electricity.

Duct layouts to the fan which cause concentration of fly ash are common. Frequently erosion will occur only on one side of a double-inlet fan in spite of the fact that the gas is equally distributed. Right-angle turns ahead of the inlet box are the usual cause of this condition. Splitter sheets continuing upstream into the straight duct will often distribute the fly ash to both inlets and so reduce the wear on any one area.

Additional Steps Necessary

Having done all that is possible to reduce the amount of fly ash in the system two other steps are necessary; these are:

1. Remove fly ash by some form of a collector ahead of the fan wheel.
2. Use a fan designed to resist abrasion.

The inclusion of fly-ash collection systems in power plant design is rapidly becoming standard practice and without doubt the practice will increase after the war. Most power plants designed within the past few years have either installed fly-ash collecting systems or have provided space and fan capacity for such installation at a later date. This is excellent engineering and should be done in every plant.

Whether to use a built-in fan type, multiple-cyclone, multi-tube or electric type of collector depends upon the conditions which are different for each plant. Provision for, or installation of, some type should be made however. Collection should be made before the fly ash reaches the fan wheel.

Design of an induced-draft fan to withstand abrasion appears at first to be a comparatively easy task. In the days of low pressures and low speeds the problem was solved simply by the addition of extra metal in places subject to wear. However, with the advent of high pressures, high speeds were required and centrifugal stresses in the wheel blades became a critical factor in fan design. Narrow blades of heat-treated alloy steel became necessary. A high-speed heat-treated alloy rotating member requiring very careful balance should not be used to absorb abrasive wear. The induced-draft wheel is the most carefully made and expensive part of the induced-draft system. Good engineering requires that parts which wear on a wheel be reduced to a minimum. Wear, if inevitable, should be made to take place on the housing, liners, vanes or other non-rotating parts which can be built rugged and of inexpensive mild steel or cast iron, and replaced or patches welded on when necessary. When wear takes place on the wheel the maintaining of balance becomes a constant problem.

Fig. 3—Another example of erosion at the center plate

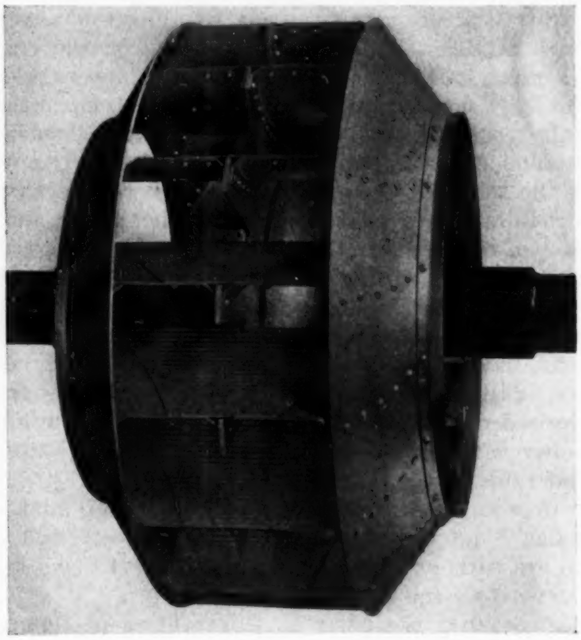

Fig. 4—A design of erosion-resistant induced-draft wheel

Locations Subject to Wear

While the location of wear is not yet predictable with any degree of success, a study of many eroded wheels points to certain locations where wear is most likely to occur. The most common location is at the junction of the blade and the center plate. The momentum of the fly ash in changing from a path through the inlet to a path at right angles causes the dust to be thrown against the center plate. The blades of the fan in accelerating the gas and dust concentrates this stream into a pocket on the face of the blade against the center plate. With the dust so concentrated wear is usually very rapid. A record of replacement blades ordered in three years for one plant operating at high rating and with high ash without collectors, showed an average life of only ten weeks per set of blades with several center plates replaced in the same period. Figs. 2 and 3 show representative examples of this erosive condition particularly at the center plate.

Considerable study and many changes in wheel construction and material have been made to overcome this condition. A very successful design is shown in Fig. 4. The center plate, while retained for blade support and rigidity, has been cut away at the face of the blades. The two streams of concentrated dust from the two inlets, instead of impinging against the center plate, now meet. The energy is absorbed by the streams themselves instead of by the center plate. A wearing plate is used to cover the junction of the two blades. This wearing plate is hooked under the leading edge of the blades and is riveted on, so as to be readily replaceable if necessary. It is built of floor plate, the ribs at right angles to the flow acting as deflectors to keep the ash from sliding along the plate and so causing abrasion. Several years' operation under severe duty has shown a very satisfactory life record.

Abrasive-Resistant Metals Not Recommended

The use of abrasive-resistant metals for blade construction has not proved as satisfactory as had been anticipated. Most materials with a very high Brinell hardness number, while having an excellent record on sliding friction wear, have been disappointing in tests on wheels. Most of these materials are very hard and brittle and the impact shock appears to cut through as readily as with mild steel. Some hard coatings welded on the surface show promise but the technique and skill of application is extremely important. The slightest opening will permit undercutting which will render the remainder of the protective coating useless. Fig. 5

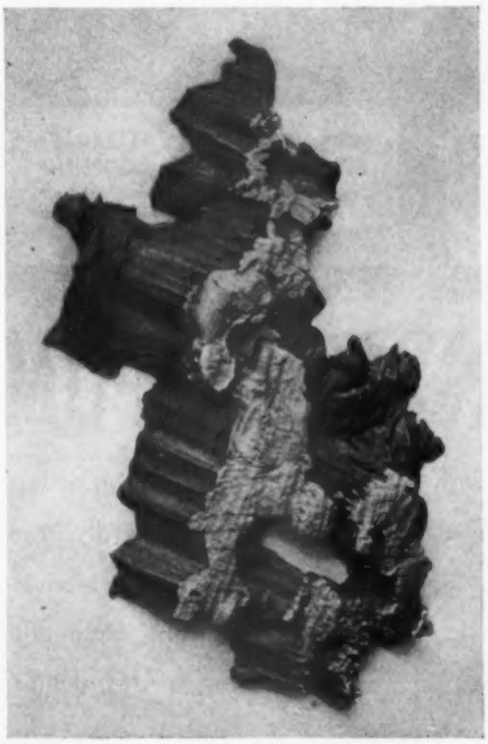

Fig. 5—Erosion of a 1/4-in. steel plate only partially stopped by coating

shows a section of a 1/4-in. steel plate with a protective coating which was eroded completely through in spite of the protection afforded on much of the surface. It is hoped the new developments and experience resulting from the war will make this promising solution of the problem effective.

Fan blades using heat-treated alloy steels should never be welded or have such coating applied without checking

Fig. 6—Determining fly-ash erosion of metal in Dust Research Laboratory

with the manufacturer of the wheel. The application of such uncontrolled and localized heat may seriously weaken the blade and lead to cracks and failure. On blades of mild steel, welded beads are sometimes added at right angles to the gas flow. They must be close together to be effective and even then there still remains a tendency to undercut the bead. The fan wheel should always be rebalanced after such work

Worn places on fan wheels are sometimes welded over to extend the life of the wheel. In such cases the blade material should be carefully checked before attempting welding.

Investigations Being Continued

Little scientific data on the effect of fly ash on metals under various conditions have been available. Comparative tests of an operating induced-draft fan, by making each blade of the test wheel of different material, have been made and are still continuing.

A whole series of tests is now being conducted on the effect of fly ash on materials and surfaces which might be used in fan or collector design. Fig. 6 shows a special testing apparatus developed in the Dust Laboratory of the writer's company for this purpose. Erosion from fly ash of various sizes and types on specimens of various materials is accurately measured at various velocities and angles. Much work is still to be done but already interesting and valuable results have been obtained toward a solution of the problem.

Coal-Handling Installation for New Plant Extension

By M. L. WHITING

Commonwealth & Southern Corp., Jackson, Michigan

At this central station, whose identity under present conditions cannot be revealed, an unusual coal-handling system has been laid out to serve both the old plant and the new extension. Designed to handle up to 200 tons per hour, the system provides the utmost flexibility without sacrificing available coal storage space. Flight conveyors are employed and all operations are interlocked. Precautions have also been taken to avoid any dust nuisance.

OF THE coal-handling installations made in recent years, one is unique in many respects and should be of interest to those having to do with the development of layouts of equipment for handling coal in considerable quantity. This particular installation was made to serve an existing 60,000-kw low-pressure plant and also a new extension containing a pulverized-coal-fired steam generating unit of 450,000 lb of steam per hour capacity and one 35,000/40,000-kw turbine-generator, with provision for a future similar extension.

The plant is located at the foot of a high bluff. The top of the bunkers for the existing plant as well as the coal storage and coal track are all at the top of the bluff, while the top of the bunkers for the new extension is about 15 ft higher.

Coal for the existing plant is dumped directly from tracks or cars into the bunkers, and that from storage plant is loaded into cars by means of a grab bucket.

The problem was to develop an arrangement of coal handling that would serve the extension from trucks, cars or storage, to convey crushed coal from trucks or cars to storage, or to serve the existing plant with coal from storage. It was complicated by the necessity of keeping the existing plant in operation and also the limited amount of available space without sacrificing too much storage capacity.

Reference to the general ground plan (Fig. 1) and elevation (Fig. 2), also the schematic arrangement (Fig. 3), will show the extent and shape of the coal storage area, general coal-handling arrangement, relation of the new extension to the existing plant, existing bunkers, and the coal track trestle over which the coal is transported to the existing plant and dumped directly from trucks or cars into the bunkers.

A brief explanation may be in order outlining the reasons for adopting the layout as shown which other-

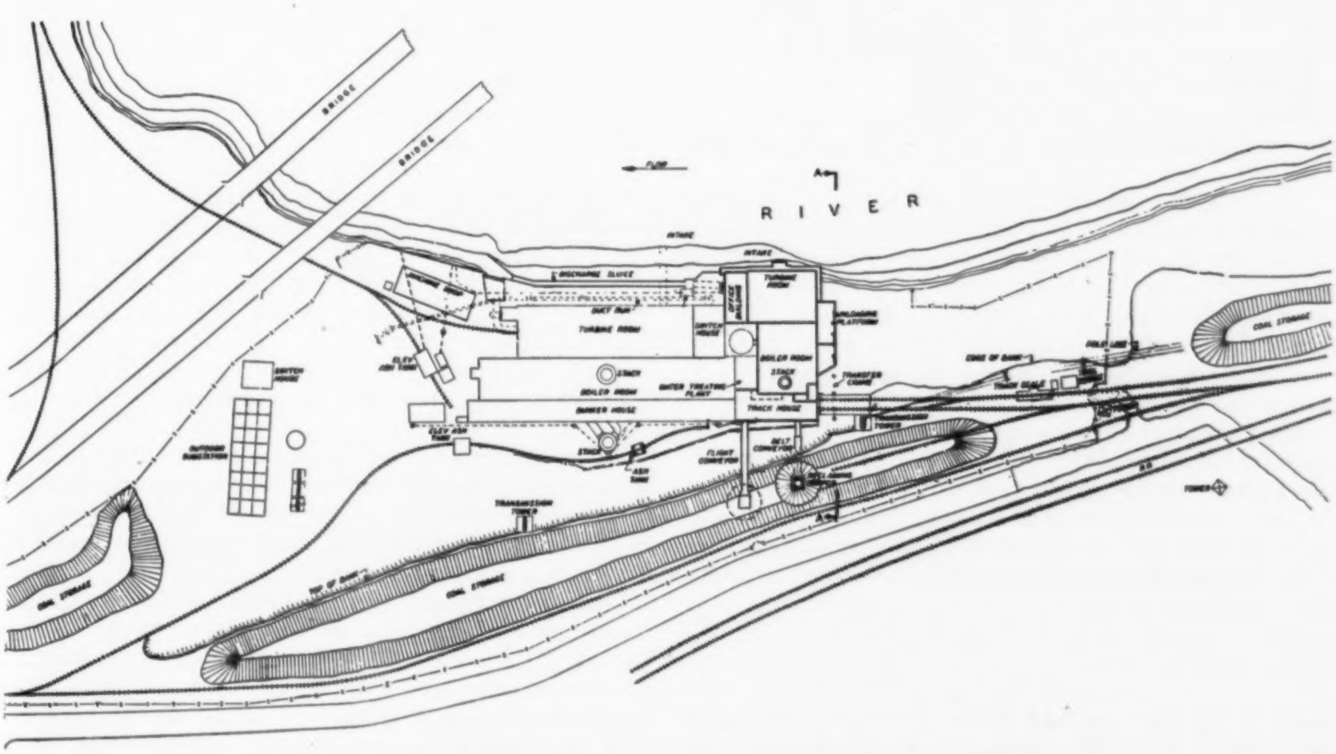

Fig. 1—General ground plan showing plants and coal-handling system

wise may at first appear to be somewhat unorthodox.

Before adopting this layout, a number of schemes were considered in which the coal would be elevated to the bunkers and to storage by means of inclined belt conveyors. In all of these the track hopper was located in the coal storage area, but they were abandoned on account of sacrificing too much storage capacity. Therefore, in order to conserve available storage area, the track hopper was finally located below the existing coal track trestle. But with the hoppers in this location, it was found impossible to elevate the coal with a single run of belt conveyor and maintain a satisfactory incline. It would have been necessary to use several belt conveyors entailing a complicated layout and considerable increase in initial cost.

Some consideration was given to the possibility of using a bucket elevator in combination with belt conveyors. However, experience with previous elevator installations of smaller capacity had demonstrated that when handling wet fine coal, the coal will pack in the buckets and result in as much as 50 per cent reduction in capacity. Also, the nature of the construction of an elevator, particularly when enclosed, is such that it is not easily accessible for inspection, which may have contributed somewhat to the fact that such troubles have been experienced as losing a number of buckets at one time, or that the chain or belt, as the case may be, has broken and allowed the elements to drop to the bottom, resulting in serious interruptions. Due to this experience with elevators, it was believed that the reliability of the elevator is not consistent with the reliability generally demanded of other equipment for central generating stations.

Flight Conveyors Employed

As a result of investigations and further considerations, it was decided to install flight conveyors to storage and to the bunkers, these being inclined at angles of 30 and 39 deg, respectively. The construction of the flight conveyor is such that all parts may be thoroughly inspected and operation observed at any time from the stairs extending the full length of the conveyors. These conveyors will handle any kind of coal without difficulty.

The coal-handling equipment is designed for a capacity of 200 tons per hour and to take coal from trucks or cars. Provision has been made to mix coal from storage with that from the track hopper, if desired, in case storage coal is too wet for efficient operation. This is accomplished by reducing the flow of coal from the reclaiming hopper from 200 to 100 tons per hour and operating only one of the feeders from the track hopper.

Coal is dumped from cars or trucks directly into the existing bunkers for the old plant from whence it passes through a portable crusher and is fed by gravity to the stokers; or the coal may be dumped from cars or trucks into the new twin track hoppers and from there is conveyed by the two belt feeders and the belt conveyor, passing over the weightometer and the magnetic pulley, to the crusher. It may pass through the crusher or be bypassed around the crusher, then elevated to the storage pile or to the horizontal flight conveyors over the new bunkers by the inclined flight conveyors previously mentioned. From the horizontal flight conveyor, the coal will be distributed to the bunkers.

Coal may also be dumped from trucks on the storage pile, or unloaded from cars to the storage pile with a grab bucket from the track south of the storage.

When reclaiming coal for the new plant extension, it is taken from the reclaiming hopper by the reclaiming belt conveyor and transferred to the belt conveyor going to the crusher over the weightometer and magnetic head pulley; then passed through the crusher or bypassed around the crusher, where it is elevated to the horizontal flight conveyor over the new bunkers by the 39-deg inclined flight conveyor. From here it is distributed to the bunkers.

When reclaiming coal for the existing plant, it is reclaimed as previously described, but is discharged from

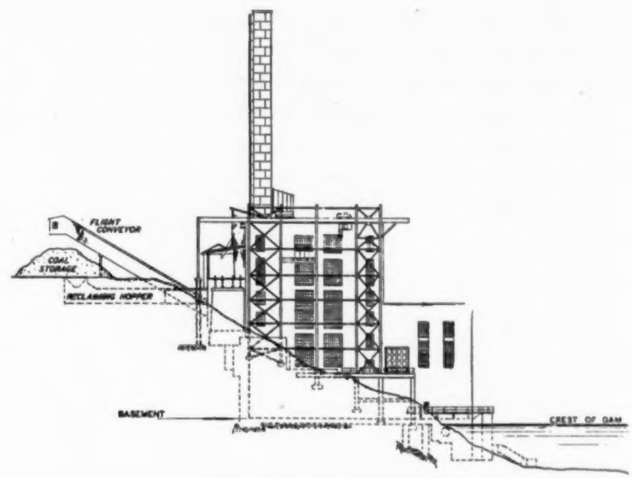

Fig. 2—Elevation of extension

the head end of the inclined flight conveyor to a railroad car. The car is then moved across the existing trestle by means of an electric locomotive and it is dumped directly into the existing bunkers.

Every effort has been made to eliminate the dust nuisance. The flight conveyor over the bunkers has been totally enclosed, and all transfer and loading points are enclosed and sealed as tightly as possible. Air is constantly discharged from the bunkers, flight conveyor and enclosures during conveying operations. The dust from the bunker exhauster is discharged into the breeching just ahead of the stack. By maintaining a flow of air inward into the bunkers and enclosures through the seals and any crevices, the dust is effectually prevented from escaping into the rooms.

Provision is made for future extension to the east. The only modification will be an additional flight conveyor over the bunkers.

The main storage area is approximately 1000 ft long with an average width of about 80 ft and has a capacity of about 28,000 tons when piled to height of 20 ft. Several auxiliary piles of unknown capacity are located at remote areas on the property.

Coal will be hauled from the initial storage pile to the storage area and from the storage area to the reclaiming hopper with a tractor and wheel scraper. It will be pushed into the reclaiming hopper from a distance of about 200 ft with a bulldozer. When depositing coal with the scraper, the coal will be distributed in even layers. Only crushed coal with a sufficient amount of

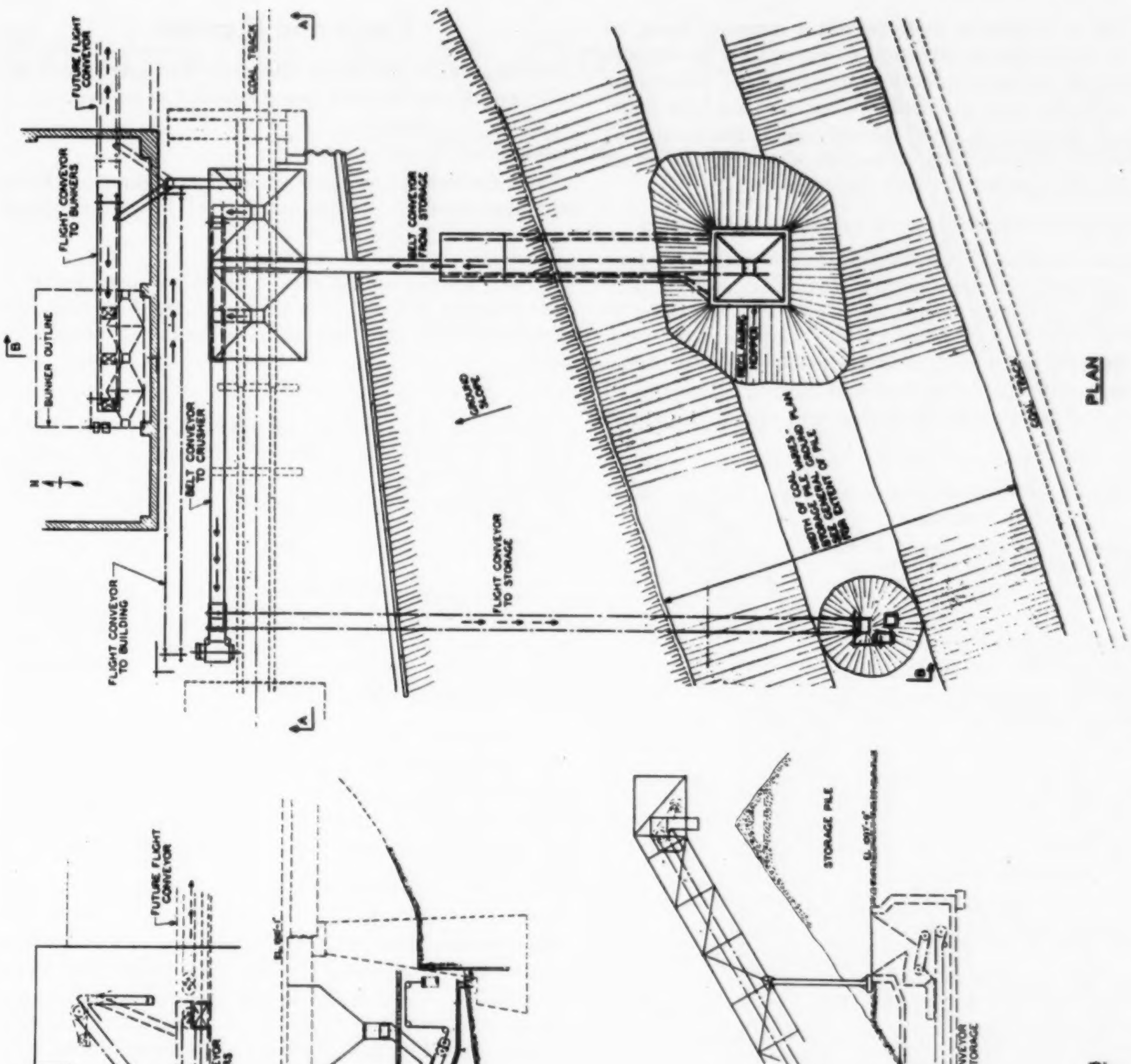

Fig. 3—Schematic arrangement of coal-handling system

fines will be stored so as to permit a compact mass, in order to avoid the penetration of enough air to support combustion. The compacting action of the caterpillar tread bulldozer does not depend entirely upon its weight, which is only about eight pounds per square inch of tread area, but also upon its action of getting the small particles interspersed between the large ones.

Sequence Operation Assured by Interlocklng System

The interlocking system is designed in such a manner as to interlock all equipment in sequence, so that normally it is impossible to pile up coal at any point due to improper operation or failure of any piece of equipment. Each piece of equipment is interlocked with that ahead of it, so that it must be started in sequence. This makes it necessary for the operator to patrol the entire length

SCHEDULE

Routing of Coal from Station to Station Thru Conveyor Units indicated by this Mark "X"

	Track Hopper to New Bunkers	" " Existing Bunkers	" " Storage	Storage to New Bunkers	" " Existing Bunkers
Reclaiming Hopper				X	X
Rack & Pinion Gate				X	X
Belt Feeder				X	X
Transfer Chute to Reclaiming Belt Conveyor				X	X
Reclaiming Belt Conveyor				X	X
Track Hopper	X	X	X		
Rack & Pinion Gate	X	X	X		
2 Belt Feeders	X	X	X		
Transfer Chute to Belt Conveyor	X	X	X	X	X
Belt Conveyor to Crusher	X	X	X	X	X
Weightometer	X	X	X	X	X
Magnetic Pulley	X	X	X	X	X
Crusher - Run-of-Mine	X	X	X	X	X
" By-Pass, Run-of-Mine		X	X		X
" " " 1" nut & Slack from Hopper;	X	X	X	X	X
Crushed Coal from Storage					
Transfer Chute to inclined Flight Conveyor (to Bunker)	X	X		X	X
" " " " " " (to Storage)			X		
Inclined Flight Conveyor (to Bunker Flight Conveyor)	X	X	X	X	X
Transfer Chute-Inclined Flight Conveyor to Bunker Flight Conveyor	X			X	
" " " " " Cars		X			X
Cars to Existing Bunkers		X			X
Horizontal Flight Conveyor over Bunkers	X			X	
Inclined " " to Storage			X		

Fig. 4—Schedule of coal routing

of the conveying system, thereby assuring him that no repairs are being made on any part of the equipment. In any case, a piece of equipment is stopped either by push-button or thermal overload operation. All equipment feeding to this system will be stopped automatically.

Any individual piece of equipment may be tested by operating the "inching" button and will continue to run as long as the button is held. The inching operation facilitates the inspection of individual part.

On all equipment controlled from a remote point, provisions have been made for electrically locking out any individual piece at the nearest push-button station. This insures that no one will be able to start this equipment while inspection or repairs are being made.

The schedule showing the detail routing of coal from station to station (Fig. 4) is rather unique and was found to be convenient in conveying operating information to different engineering design sections for use in preparing the control and interlocking system. It was responsible for saving many hours of verbal explanation.

Facts and Figures

Preheated air in boiler furnaces was introduced experimentally in England about seventy years ago.

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In some lines of war production, glass gages are being employed instead of the usual steel inspection gages.

•

A well-known manufacturer of boiler instruments is now offering control panels constructed of Masonite reinforced with steel angles as a means of conserving steel.

•

According to investigations reported in a paper before The Iron and Steel Institute (England), if steel is wetted with nearly neutral chloride solutions, its corrosion-fatigue life is prolonged.

•

The much publicized wind-power plant, near Rutland, Vt., has now been in operation for about a year and a half. Rated at 1000 kw, wind conditions have been such that full capacity was attainable approximately 25 per cent of the time.

•

As of January first of this year, the total installed generating capacity in central stations amounted to 45,671,245 kw of which 31,444,271 was in fuel-burning plants. Scheduled additions for 1943 amount to 3,733,150 kw.

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Early patents on pulverized-coal firing were taken out in this country in 1866; two years later tests were made on a marine boiler so fired; and in 1877 a patent was issued in Germany covering a continuous-slagging-bottom water-cooled furnace. Pulverized coal was first applied to locomotive firing in this country in 1914. Within the next few years, installations were also made in Brazil, Chile and Japan.

•

The secrecy that long shrouded the huge hydro development now under construction in Canada has been lifted. It is the Shipshaw development of the Aluminum Company of Canada which will eventually contain twelve units, each developing up to 100,000 hp and make it rank among the world's largest hydroelectric developments.

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In reading accounts of equipment performance, one is sometimes confused as to the expressed meaning of certain terms commonly employed. For instance, *Service Demand Factor* is the ratio of the actual number of hours there is a demand for the unit to the total hours in the period covered; whereas *Service Demand Availability Factor* is the ratio of the hours in service to the hours of demand. *Capacity Factor* is the ratio of the actual output to the unit rating multiplied by the hours in the given period; and *Operation Factor* is the ratio of the hours in service to the total hours in the period covered.

Analyzing Heat Flow in Cyclic Furnace Operation

A new tool of investigation, the "heat-and-mass-flow analyzer," shows promise of fulfilling requirements as a method of solving unsteady-state heat-flow problems. The results of a direct test made on an insulating refractory brick panel are compared with those obtained from an analyzer simulating similar conditions electrically.

IN A paper given before the Metropolitan Section of the A.S.M.E. on February 24, 1943, C. B. Bradley and C. E. Ernst, both of the Johns-Manville Corporation, described the application of the "heat-and-mass-flow analyzer" in determining the optimum thickness of insulation with particular reference to heated equipment operating under periodic or intermittent conditions of heat flow.

Hitherto, the determination of optimum thickness of insulation has been largely confined to equipment operating under steady-state conditions; unsteady-state heat flow involved so many complex factors that such determinations were deemed impracticable. However, with the use of the new "heat-and-mass flow analyzer," an electrical apparatus developed by V. Paschkis at Columbia University, such problems may be solved without the laborious calculations required by former methods. The method has already been described in a paper[1] presented by Victor Paschkis and H. D. Baker, both of the Mechanical Engineering Department of Columbia University. This new method and apparatus are based on the analogy between certain electrical circuits and transient heat-flow phenomena, in which thermal capacity is represented by electrical capacity; thermal resistivity by electrical resistivity; temperature difference by voltage; and heat flow per unit of time by current.

In order to investigate a heat-flow problem, the body subjected to heat flow is considered in sections. Each section is represented by an electrical resistor and a condenser. After the analogous circuit has been set up, its ends are subjected to a voltage-time curve corresponding to the temperature-time curve in the heat problem. By simple conversion methods voltage and current time measurements yield the desired temperature and heat-flow time curves at points within the body.

One important feature of analogous electrical circuits is the possibility of applying a variable time scale. The parallel investigation of a heat-flow operation lasting many hours may be arranged in the electrical apparatus to require only several minutes, or, conversely, an operation lasting only a few seconds can be extended to last several minutes.

A direct test on a typical furnace-wall construction was made in the Johns-Manville Laboratories while the test on the analyzer was made in the Heat Transfer Research Laboratory at Columbia University. The problem chosen for comparison comprised a 9-in. thick insulating refractory brick wall panel (23 $\times$ 25 $\times$ 9 in.) with a cold surface exposed to air at 100 F and a hot surface subjected to cyclic heating as follows:

Heating rapidly to 1900 F and holding this temperature constant until eight hours from the start of the cycle, then allowing the wall to cool for 16 hours. Repeating this heating and cooling schedule until the temperature-time curves for various points in the wall were identical for two consecutive cycles.

For cyclic equilibrium, the following information was required: Total heat input over 24-hour period; average heat flow; temperature-time relations for various points in the wall, including cold surface. In addition, the heat input per cycle, for all cycles up to and including the equilibrium cycle, was desired. In the direct test five thermocouples were placed in each of six bricks, positioned roughly on a diagonal of the test panel. Readings were taken just before the test and every 30 minutes throughout the test.

Analyzer Test

For the test with the electrical analyzer, a time ratio 1:200 was selected; i.e., one hour (3600 sec) of thermal flow was represented by 18 sec of electrical flow. Based on calculations derived from the identity of form of the fundamental thermal and electrical equations the electrical circuit shown in Fig. 1 was constructed to represent the test wall. A potential difference of one volt represented a temperature difference of $8^1/_3$ F; thus 2000 F were represented by 240 volts. The time-temperature schedule for the hot surface in the direct test was followed for the hot surface on the analyzer by adjusting manually in short intervals (2 to 18 sec) the voltage imposed on the system during the heating period and by adjusting a variable "leak resistor" during the cooling period. A current of one milliampere represented a heat flow of 2160 Btu per sq ft per deg F per hour. By reading the two milliammeters shown in Fig. 1 the heat flow entering the hot surface and the heat loss from the cold surface were determined.

The correlation between the direct test and the electrical analyzer is shown in Fig. 2, by plotting temperature versus time for various points in the wall. The solid curves represent the direct test; and the points, the electrical analyzer readings. It is to be noted that the amplitude of the temperature wave decreases with

[1] "A Method of Determining Unsteady-State Heat Transfer by Means of an Electrical Analogy," by Victor Paschkis and H. D. Baker, New York, N. Y., *Trans. A.S.M.E.*, Feb. 1942, pp. 105–110.

the distance from the hot surface and that the peaks lag increasingly behind those at the hot surface.

The time required for the tests, i.e., preparation, test and evaluation, was as follows: For the direct test, the preparation required about two days, taking data about five days, calculation and evaluation of data about five days, making a total of 12 days for the entire test. For

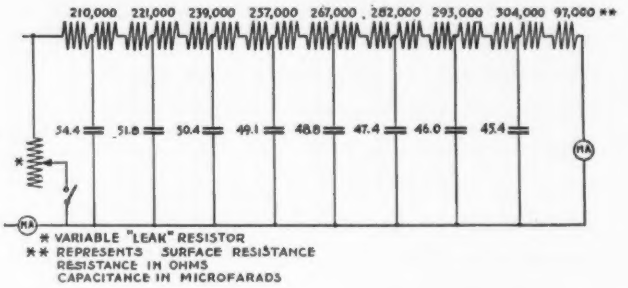


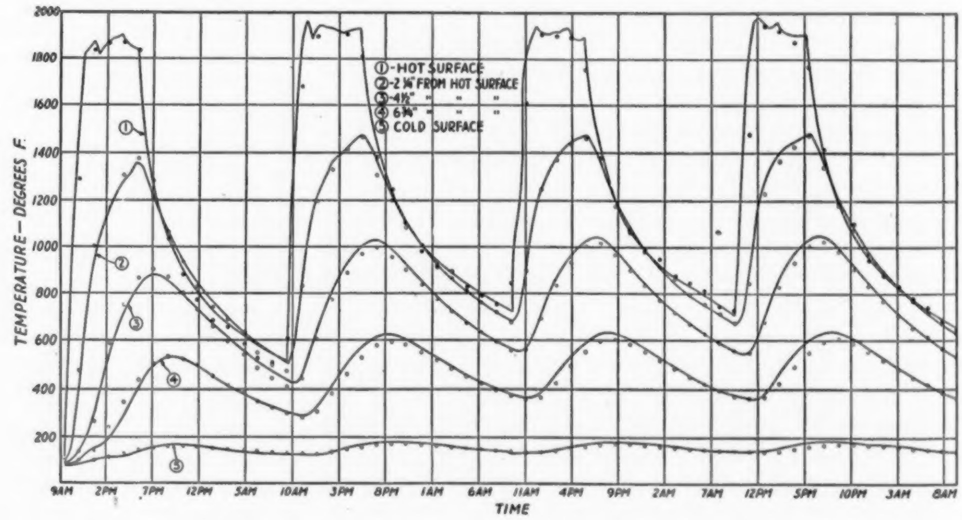
Fig. 1—Electrical circuit representing test wall

the analyzer test, preparation required 20 hours, the taking of data 30 minutes, and evaluation of data 20 hours.

In comparing the limitations of each method, it was found that a direct test on any given construction will furnish data applicable only to a limited number of cases. The time and expense involved limit the number of tests and the amount of useful information obtained. The main limitation of the analyzer is the need to know the physical constants involved (specific heat, density, thermal conductivity, film conductance) as the analyzer does not yield any answer better than the constants applied. However, these constants are fairly well known within a tolerance of plus or minus 10 per cent, and new apparatus has been developed to determine such values with a greater degree of accuracy. Theoretically further limitations exist in the selection of time ratios. Lengthy experiments (small time ratios) call for capacities and resistors possibly higher than those available. When experiments are of short duration, it is difficult to make many changes in the settings of the voltage, etc.

The result of the tests proved that the electrical analyzer gives results which check closely with the direct test in much less time and without the need of building an actual test wall.

Fig. 2—Correlation between direct test and electrical analyzer



The mechanical problems of calibration and manipulation of test equipment are considerably reduced, allowing much more extensive investigation and ease of reproducing results.

There are numerous applications of the electrical analyzer to insulation problems involving cyclical unsteady temperature conditions. Among these are:

1. The determination of average heat flow through a great variety of wall thicknesses and constructions to establish the most economical thickness and construction for a particular application.

2. In insulation applications where materials have high resistance to heat flow but low temperature resistance, the analyzer permits the determination of specific temperatures under unsteady heating operation enabling the use of lesser thicknesses of the higher-temperature materials as compared with steady-state conditions.

3. In many annealing furnaces, etc., it is necessary to control the cooling rate according to the characteristics of the material being handled. A required cooling schedule can be met by the proper choice and combination of furnace wall materials which would permit a heat loss to coincide with the cooling schedule.

4. Another problem with cyclic heating operations is to insure the operation of automatic controls without undue hunting. This involves the selection of a wall structure of such insulating value and heat capacity that it does not unduly oppose operation of the automatic control and cause it to function too often or with too great a temperature swing.

Discussion

The discussion of the paper brought forth comments from those who favored other methods of determining unsteady-state heat flow. One discusser favored the mathematical approach and the use of differential equations and curves plotted from the solution of such equations. Another favored the numerical relaxation method of Southwell which was given in a paper by Emmons at the 63rd Annual Meeting of the A.S.M.E.

The exponents of the calculation methods considered both time and expense and felt that calculations were justified in preference to either the direct test or the electrical analyzer. With the mathematical approach, it was stated that once the necessary curves are prepared each problem can be solved in about a minute, so if there are many solutions required this method might be quickest in the long run. On the other hand, if only one problem of a particular type requires a solution, it was stated that the numerical relaxation method of Emmons would be just as quick as the electrical analyzer and much less expensive.

The numerous advantages of the Analyzer were recounted by another discusser who stressed the point that some problems impossible of solution by mathematical approach are nevertheless quite readily solved by the Analyzer.

Analyzer Laboratory at Columbia

A Heat-and-Mass Flow Analyzer Laboratory was recently established in the Department of Mechanical Engineering at Columbia University under a grant from the Research Corporation, in view of the growing industrial importance of heat flow in solids, particularly under transient conditions.

The laboratory organization, under the department of mechanical engineering at the University, consists of Dr. V. Paschkis, Research Associate, and Prof. Carl F. Kayan, Executive Secretary.

The operation of this laboratory differs from that of a conventional thermal laboratory in that it is based on an electrical analogical method especially designed for the investigation of unsteady-state (transient) problems, but adaptable also for steady-state problems. Actually, heat and temperature as such are not active within the equipment. Equivalent values of electrical current and voltage take their place, with electrical capacitance replacing heat-storage values in transient heat-flow studies.

By means of the Analyzer it is possible to study the various phases of transient heat flow including time-temperature relations in solid parts and structures. Events of hours in actual duration may be compressed with graphical representation into the space of minutes and, conversely, short-time durations of minutes or seconds may be expanded into a much longer period. Thus interpretative analysis may readily be made. It is also possible to make adjustments during the experiment, to account for changes in physical properties of materials. Thus, in a sense, the Analyzer is an electromechanical "brain," carrying out operations that hitherto have only been possible by tedious and time-consuming mathematical or graphical analysis, if at all.

Applications in Steam Power Field

In steam power installations there are a variety of problems which lend themselves to investigation by means of the Analyzer. Some of these are suggested by the laboratory staff who have generously furnished us with the following notes:

1. Problems Dealing With the Refractory Walls of a Boiler

(*a*) Heat loss due to heat storage: If the boiler is not operated long enough to reach the steady state in the furnace wall, the stored heat cannot readily be calculated. It can be determined by means of the Analyzer.

(*b*) Boiler furnaces working at regularly changing loads have wall losses which are a function of the load curve and the wall design. The wall losses can be found with the aid of the Analyzer.

(*c*) Selection of best-suited lining, including insulation can be based on a comparison of heating-up losses and losses in intermittent work.

(*d*) Through-metal causes additional losses which are mostly underestimated. The increase of loss is far greater than that found from a mere addition of the heat flow by metal to that of the wall lining. The problem of increased losses by such through-metal is well suited to investigation on the Analyzer.

(*e*) Suspended arches: These represent special and important applications of the through-metal problem. Not only does the question of heat loss enter but, even more important, the question of mechanical stability of the suspended arch.

2. Problems Dealing With Tubes and Drums of Boilers

(*a*) Temperature distribution and heat flow in the walls of boiler tubes (steady-state Consolidated Edison study). The influence of slag and oxide deposits can readily be represented.

(*b*) If a boiler-tube filled with superheated steam suddenly receives a slug of relatively cool water, the inside surface undergoes a sudden quench. The tube temperature-time history can be studied.

(*c*) A similar problem occurs at the point where rolled-in feeder tubes are originally at a constant temperature. Through the influx of cool feedwater they may shrink while the surrounding metal of the drum still retains a fairly high temperature. The result is a leak. The temperature-time history of the tube can be investigated.

(*d*) The internal stresses occurring in a large thick boiler drum during a quick heating-up can be investigated.

(*e*) Study of the heat generation in a steady steaming tube, where the heat is transmitted really not steadily but at a high frequency.

3. Problems Dealing With Steam Pipe Lines

(*a*) Steam pipe lines operated intermittently should have an insulation which is of less thickness than that of a continuously operated pipe. The Analyzer permits of the determination of a correct value.

(*b*) Insulated and non-insulated steam pipe lines, buried in the ground and subject to varying temperatures of the ground, show a temperature behavior which is different from that of lines run in surroundings at constant temperature. These conditions are subject to ready investigation on the Analyzer.

During the period of its existence, the Analyzer has been used on a number of specialized technical problems with gratifying success. The laboratory investigations have covered transient problems of actual long-time durations, as well as problems involving extremely short-time durations, thus involving both time-compression and time-expansion.

Program for Midwest Power Conference

With the announcement of the preliminary program, plans for the Midwest Power Conference, arranged by Illinois Institute of Technology, are rapidly taking shape. The 1943 conference will be held Thursday and Friday, April 8 and 9, at the Palmer House in Chicago. It will be the 17th Annual Meeting of the Conference and its sixth under its present sponsorship.

Topics for discussion include, central-station practice, electrical distribution, diesel power, fuels and combustion, and industrial power plants, their protection and maintenance. Thirteen speeches on these various subjects are listed in the preliminary program.

An additional sponsor of the Conference is the Engineers' Society of Milwaukee which brings to eight the number of engineering societies sponsoring the Conference. These include the Chicago sections of the American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mechanical Engineers, American Society of Mechanical Engineers, Illinois sections of the American Society of Civil Engineers, American Society of Heating and Ventilating Engineers, and the Western Society of Engineers. There are also nine cooperating colleges.

Featured speakers will be C. W. Kellogg, president of the Edison Electric Institute, who will give the keynote address, and Col. James L. Walsh, who will be the speaker at the "All-Engineers" Dinner on Thursday night. Mr. Kellogg will speak on "Electric Power Supply" at the morning session on Thursday and Colonel Walsh, who is chairman of the War Production Committee of the A.S.M.E., will discuss "Logistics, the Science of Survival." James D. Cunningham, will serve as toastmaster at the dinner.

One session on the program already looms as unique in the Conference annals; it is that on plant protection, and will be conducted by all-army personnel. Lt. Col. A. G. Coulson and Maj. Ralph W. Applegate of the Sixth Service Command will be the speakers. Colonel Coulson's subject is "War-Time Protection of the Power Plants," and Major Applegate will discuss "Accident Prevention in Public Utilities." The former is chief of the Continuous Security Branch, and the latter, chief of the Industrial Safety Branch, of the Sixth Service Command.

The preliminary program is as follows:

THURSDAY, April 8

9:00 a.m.

REGISTRATION, Palmer House

10:15 a.m.

OPENING MEETING. H. O. Croft, Chairman

"Address of Welcome," by H. B. Gear, Vice President, Commonwealth Edison Company, Chicago

"Response for the Cooperating Institutions," by M. P. Cleghorn, Professor of Mechanical Engineering, Iowa State College

"Electric Power Supply," by C. W. Kellogg, President, Edison Electric Institute

"Practical Education in War Time," by Philip W. Swain, Editor of *Power*

12:15 p.m.

Joint Luncheon with A.S.M.E., J. R. Michel, Chairman

2:00 p.m.

POWER PLANT PRACTICE, R. K. Behr, Chairman. (Sponsored and arranged by the Power and Fuels Division, Chicago Section, A.S.M.E.)

"Turbine Blade Deposits," by Frederick G. Straub, Research Professor of Chemical Engineering, University of Illinois

"Conversion from Oil to Coal-Fired Steam Generating Units," by Samuel I. Rottmayer, Mechanical Engineer, Chicago

3:45 p.m.

Electrical Distribution. Session No. 1. J. E. Hobson, Chairman

"Application of Shunt Capacitors to Meet Emergency War Conditions," by Chas. F. Wagner, Manager, Central Station Engineering, Westinghouse Electric and Manufacturing Co.

"Resonant Grounding for Long-Distance Power Transmission Systems," by W. A. Lewis, Director, School of Electrical Engineering, Cornell University

"Design of Direct-Current and Low-Frequency Bus Systems," by Thomas J. Higgins, Associate Professor of Electrical Engineering, Illinois Institute of Technology

3:45 p.m.

Industrial Power Plants. H. L. Solberg, Chairman

"Use of Automatic Control to Increase Plant Capacity," by H. H. Gorrie, Design Engineer, Bailey Meter Co.

"Guideposts on the High Pressure Road," by D. B. Jones, Hall Laboratories, Inc.

"Engineering Aspects of Product Design Resulting in Power Saving," by Robert B. Smith, Elliott Company

6:45 p.m.

"All Engineers" Dinner

Toastmaster: James D. Cunningham, President, Republic Flow Meters Co.

Speaker: Colonel James L. Walsh, Chairman, War Production Committee, A.S.M.E., "Logistics, The Science of Survival"

FRIDAY, April 9

9:00 a.m.

Plant Protection, John I. Yellott, Chairman

"Accident Prevention in Public Utilities," by Major Ralph W. Applegate, Chief, Industrial Safety Branch, Sixth Service Command

"War Time Protection of the Power Plants," by Lt. Col. A. G. Coulson, O.D., Chief, Continuous Security Branch, Sixth Service Command

10:30 a.m.

Plant Maintenance, R. W. Jones, Chairman

"Breaking Bottlenecks in Piping Materials," by G. W. Hauck, Manager, Engineering Sales, Crane Co.

"Boiler Maintenance Under War-Time Conditions," by A. C. Foster, Foster Wheeler Corporation

12:15 p.m.

Joint Luncheon with A.I.E.E., J. C. Woods, Chairman

Speaker: F. W. Hollister, Chief Electrical Engineer, Sargent & Lundy. "Conservation in Design of Power Stations"

2:00 p.m.

Electrical Distribution. Session No. 2

"War-Time Industrial Power Applications of Electrical Equipment," by D. L. Beeman, General Electric Co.

Discussion Leader: J. J. Orr, Chairman, Committee on Industrial Power Applications, A.I.E.E., New York

2:00 p.m.

Diesel Power. Hugh E. Keeler, Chairman

"Heavy-Duty Stationary Diesels," by B. V. E. Nordberg, Nordberg Manufacturing Co.

"Effect of Fuel Composition on Deposition in Diesel Engines," by L. E. Hebl and L. W. Griffith, Shell Oil Co.

3:45 p.m.

Fuels and Combustion, R. E. Summers, Chairman

"Effect of Coal Sizing on Efficiency and Operation of Mechanical Stokers," by Otto de Lorenzi, Assistant General Sales Manager, Combustion Engineering Co.

"Possibilities and Limitations of Small Hand-Fired Furnaces," by J. R. Fellows, Assistant Professor of Mechanical Engineering, University of Illinois

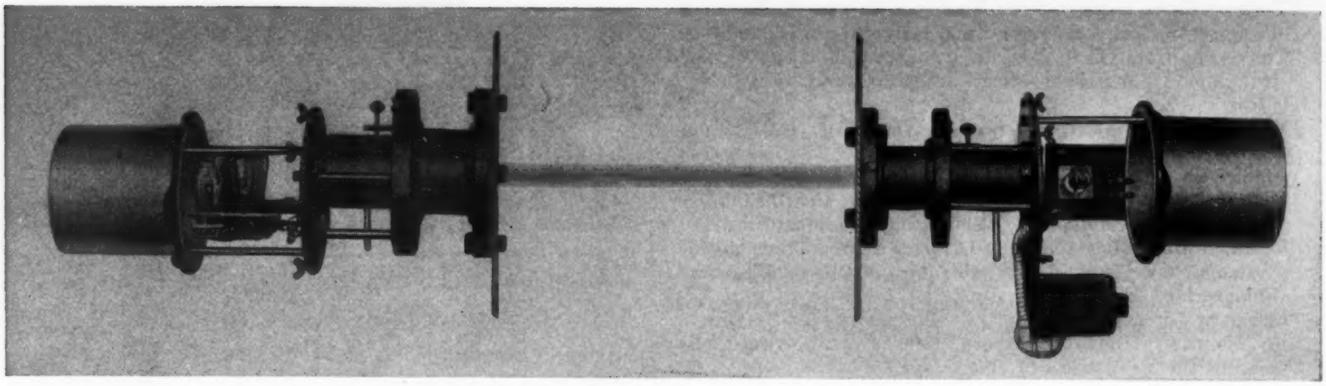
7:30 p.m.

Army Engineering Hour, Alex D. Bailey, Chairman

"Repairs and Utilities Activities at Army Cantonments," by Col. G. F. Lewis, Chief, Repairs and Utilities Branch, Construction Div., U. S. Army

"The Fuel and Heating Program at Army Cantonments," by Lt. Col. Louis C. McCabe, Chief, Heating and Refrigeration Section, Construction Div., U. S. Army

"Power and Lighting Problems at Army Cantonments," by J. A. Heffernan, Electrical Facilities Unit, Construction Div.



What is the most accurate system of automatic combustion control for pulverized coal or oil firing?

ANSWER: **The ELECTRIC EYE SYSTEM is the most accurate system—*regardless of price!***

Which is the simplest system of automatic combustion control?

ANSWER: **The ELECTRIC EYE SYSTEM is incredibly simple—most easily understood.**

Does the **ELECTRIC EYE SYSTEM** ***require flue-gas analysis?***

ANSWER: **No. The ELECTRIC EYE SYSTEM needs no flue-gas analysis—has no troublesome flue-gas piping, flue-gas cells, filters.**

Has the **ELECTRIC EYE SYSTEM** ***any delicate parts that can clog or jam?***

ANSWER: **No. It has no orifices, no filters, no pilot valves, no square-root cams; its Electronic Relay has no open contacts, no moving parts.**

Can the same **ELECTRIC EYE SYSTEM** ***be used with either pulverized coal or oil?***

ANSWER: **Yes. Sequence of operation is identical with either coal or oil firing. With the ELECTRIC EYE SYSTEM you can shift from oil to coal, or reverse, with practically *no change* to controls or adjustments.**

Is the **ELECTRIC EYE SYSTEM** ***something new?***

ANSWER: **No. There is nothing unproved or experimental about the ELECTRIC EYE SYSTEM. Commercial installations have been in service for five years. Its efficiency is endorsed by large plant users. Every installation is made and *fully guaranteed* by a thoroughly competent, responsible engineering organization which for twenty years has specialized in combustion control equipment.**

THESE CLAIMS can be fully sustained to the satisfaction of the most conservative engineer. We cordially invite you to investigate them for your own information and benefit.

Send for your copy!

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MANUFACTURERS OF THE FIRST SUCCESSFUL ELECTRIC EYE SYSTEM OF COMBUSTION CONTROL

The American Engineer and the War Effort

An address given by Dr. Andrey A. Potter, Dean of Engineering at Purdue University and Chairman of the National Advisory Committee on War Training in Engineering, Science and Management, upon the occasion of his receiving the Washington Award for 1943 at Chicago on February 24. The citation was "for distinguished leadership in engineering education and research, and patriotic service in mobilizing technical knowledge for victory in war and peace."

THE past fifteen months have witnessed many changes which are greatly challenging the ingenuity of our profession. Our former abundance of man-power and raw materials now seems like a mirage, as acute shortages have developed which are seriously affecting not only industry but also civilian needs. Engineers and scientists are endeavoring to meet both the scarcity of man-power and the scarcity of materials. They are inaugurating specialized training programs, methods of upgrading, more efficient management, and greater mechanization to meet the problems resulting from labor shortage. They are developing new substitute products to relieve the strain on scarce materials. Furthermore, through better utilization of plant capacity and transportation facilities, they are greatly increasing the quantity of essential materials available for war production. It is to the lasting credit of engineers that the steel industry has been able to double its output since 1939 with only slightly increased capacity. It should prove most gratifying to our colleagues in the transportation field that our railroads are carrying about two and one-half times the freight carried in 1918, with less rolling stock.

The enormous demands that have been made for electric power in connection with war production are being met by a better integration of existing facilities, greater use of reserve capacity and a greatly increased use factor. The story of the conversion of our automotive industry to meet war needs, when fully told, will reflect enormous credit upon those skilled in the engineering and production techniques. The growth in quantity of output and improvement in quality which have been achieved by the airplane and ship-building industries during the past 30 months is another manifestation of the engineering talent in our land.

The public at large is beginning to realize that American engineers can do most with least in the shortest possible time. Never before, in war or peace, have the members of our profession commanded such public respect and exerted such outstanding influence as they do today.

Shortage of Specialists

These American engineers and scientists, however, are too few to carry the great task entrusted to them. Although we speak more often about the scarcity of tin, copper and steel, the fact remains that our greatest shortage is not in materials but in men and women with specialized skills, particularly engineers and scientists, who cannot be trained in a few days or even in a few weeks. The output of engineering colleges, which was barely sufficient to meet the needs of industry during normal times, is falling very short of satisfying the most critical needs of our armed forces and of our war industries.

The present War Training Program in Engineering, Science and Management under the auspices of the U. S. Office of Education, through intensive in-service and pre-service courses on the college level, has been most helpful in supplementing the output of engineering colleges by training men and women for industry as assistants to engineers, technicians, inspectors, draftsmen, production supervisors and commissioned officer specialists for the armed forces. Under this program over 660,000 people were trained or retrained from October 9, 1941, to June 30, 1942, and it is expected that by the end of the present fiscal year, June 30, 1943, the number who have received such training since October 9, 1940, will exceed one and one-quarter million people.

While the War Training Program in Engineering, Science and Management, under the auspices of the U. S. Office of Education, is meeting a critical need for specialized personnel, the shortage of fully trained engineers for service to war industry and in the armed forces is becoming more acute. The majority of our engineering colleges are attempting to alleviate this situation by operating on a continuous year round or expedited plan, which will make available about a fourth more engineering graduates during the year ending June 1943. This plan, by reducing vacations to a minimum, makes it possible for a high-school graduate to complete the requirements for a bachelor's degree in engineering in two and two-thirds or three years, instead of four years, and without any appreciable lowering of standards.

Role of the Engineering Colleges

There is little dependable information concerning the use which the armed forces will make of our engineering colleges. One thing is certain. Our educational institutions of higher learning "will not be taken over by the government." The Army is planning to send, between March 1 and July 1, 1943, to higher educational institutions, mainly engineering and medical schools, about 150,000 young people in uniform, after these inducted soldiers have completed a 13-week indoctrination training period. The Navy expects to send to engineering colleges about 75,000 people between May 1, 1943, and January 1, 1944. These students in uniform will pursue prescribed programs on the engineering college level, which will require about 60 clock-hours per week in class and preparation. It is expected that the prescribed program will differ only slightly from the approved normal curricula of engineering colleges, but will be shorter, more specific, and will devote little time to humanities and social sciences.

It is to be expected that the product from the prescribed curricula will not be so well prepared as are our present engineering graduates, although the soldiers sent to colleges will have been carefully selected through certain screening tests, and will have no financial worries, because the government will pay their tuition and subsistence, in addition to a private's pay of $50.00 per month.

While the above plan will make available a large number of fairly well-prepared engineers for the armed forces, the need for engineers on the part of war industries is bound to become more and more critical. The engineering colleges will, no doubt, be used to capacity for special instruction of value to the armed forces, but unless the war industries make their wants known to our government, the supply of engineers for industry will be very greatly curtailed. Our war industries will continue to need a steady replacement supply of engineers for the planning, design and mass production of armaments and other munitions of war. The engineering colleges of our country must continue to be the major sources of this supply. Several of our leading engineering societies have endeavored, through resolutions to the President of the United States, to impress upon our government that the effective prosecution of modern mechanized warfare demands that an adequate supply of engineers is insured for war industries as well as for the armed forces. While Selective Service has been fairly liberal in deferring engineering students who have completed at least one year's work in an accredited professional engineering curriculum, the needs of war industry will not be satisfied until an industry reserve is set up so that young people can prepare for service to war industry under conditions which are not materially different from those planned by the Army and Navy.

Few Deferments Anticipated

It is felt that very few engineering students will apply for deferment when the majority of the men students enroled in engineering colleges are in uniform. Our government must be fully advised about the needs of our war industries for engineers who have the ability to plan, design, improve and supervise mass production of equipment and scientific devices needed by our armed forces. United action on the part of our profession and particularly by engineers connected with war industries is essential in order to insure an adequate and continuous supply of well-educated and thoroughly qualified engineers for service to the war industries as well as in the armed forces of our land. It is also important that those in authority in our government are fully impressed with the fact that in modern mechanized warfare there is as much need for commissioned officers with superior engineering knowledge as there is for commissioned officers with strategic and tactical skill and that such engineering knowledge cannot be imparted through short courses of a few weeks. Production of high-grade engineering talent does not take place quickly or automatically, any more than does the production of highly complicated armaments. The fully prepared and well-educated engineering college graduate is needed in large number both for war industries and for the armed forces.

Totalitarian states have sought abundant life by exploiting the assets of all for the benefit of their unscrupulous groups, and have resorted to banditry, racketeering and trickery to attain their objectives. In contrast with this, our creative people, stimulated by our patent system and aided by a foresighted government that has always encouraged individual enterprise, have converted this country, in the short period of 153 years, from a small, struggling nation, into the most powerful industrial people in the entire world. During the same period, the standard of living of our people has raised from bare subsistence to a point where we enjoy the highest living standards known in history. If we wish our nation to advance in the future as it has in the past, we must preserve free enterprise, maintain our standards of engineering education and safeguard our patent system.

Influence of War-time Inventions on Post-War Progress

It is significant that most of the epoch-making inventions of the past 150 years are the product of American genius. War incentives have stimulated invention and developments which are resulting in new devices of great value to our armed forces. While some of these creative achievements of the past two years must remain military secrets for a long time in the interest of national defense, many others should prove most valuable during the post-war period in developing new opportunities for employment and in raising the standards of living of people the world over. If maximum use is to be made of our inventive talent to insure victory in our present struggle and to meet adequately the challenge which will be ours during the post-war period, we must make certain that we have a sound patent system which protects the inventor and investor alike. Few realize that there is a difference between an invention and a marketable product. An invention, to be commercialized, usually requires considerable expenditure for research and development. To benefit the public through new and useful inventions, not only the invention but its development requires the assurance of protection. Our patent system, which was created by an Act of Congress, signed by President George Washington on April 10, 1790, has provided an incentive to the inventor and to capital for the encouragement of research and development needed to commercialize an invention. Under our patent system the production and utilization of new ideas have taken place at a very rapid rate, and in amount which has outstripped all other lands.

Patent System Studies

Like all institutions created by human beings, our patent system is not perfect, but it has demonstrated its merit and has served as the model for the patent systems of all industrial nations. Six different groups have appraised our patent system during the past 30 years. These include the President's Commission on Economy and Efficiency (1912), the Patent Committee of the National Research Council (1919), the Committee on Patent Office Procedure of the Department of Commerce (1926), the Science Advisory Board (1935), the Joint Patent Inquiry of the National Association of Manufacturers (1940) and the Temporary National Economic Committee (1938–1941). About a year ago the President of the United States, by Executive Order No. 8977, created the National Patent Planning Commission "to conduct a comprehensive survey and study of the American patent system, and consider whether the system now provides the maximum service in stimulating the inventive genius of our people in evolving inventions and in furthering their prompt utilization for the public good; whether our patent system should perform a more active function in inventive development; whether there are obstructions in our existing system of patent laws, and, if so, how they can be eliminated; to what extent the government should go in stimulating inventive effort in normal times; and what methods and plans might be developed to promote invention and discoveries which will increase commerce, provide employment and fully utilize expanded defense industrial facilities during normal times."

The National Patent Planning Commission has concerned itself to date mainly with studies bearing upon some of the more important questions of policy arising in connection with the patent system itself, such as the problems arising in the granting of patents, their adjudication and use. It has endeavored to clarify conceptions regarding the standard of patentability which would insure adequate encouragement to creative research and ingenuity, as well as the attraction of capital essential for the development and commercialization of inventions. In its first report to the President it will make suggestions for legislation to aid in enhancing public and judicial confidence in the American patent system while fully protecting the inventor and investor.

Determination of Government Policy

The National Patent Planning Commission is also undertaking a number of studies which have as their objective a policy for government, with reference to the aquisition, control and management of patents owned by government, those acquired by purchase and seizure, those belonging to employees of government and patents growing out of research by government agencies and by its contractors. Our government now controls thousands of patents and many important patents will result from war research which is now being carried on for the government in war industries and at educational institutions. The policy of government with reference to these patents is of major concern to our profession and to American industry. Suggestions will be welcome as to a policy for our government with reference to patents it now owns or controls, which will fully protect American industry and which will adequately reward the inventor.

The most important phase of the assignment of the National Patent Planning Commission is covered in the last part of the President's order and relates to the important problem of stimulating inventive talent for the benefit of the war effort and for the purpose of utilizing the expanded war industries during the post-war period. What should our government do to stimulate inventive effort and what

plans and incentives should be developed to encourage research and invention which will increase commerce, provide employment and fully utilize defense industrial facilities during normal times? This problem is of special concern to the engineering profession as well as to the public at large, if the technical skill and equipment which we are now building up to meet the needs of the war effort are utilized most effectively to provide full employment and a higher standard of living when peace becomes a reality. Radio emerged from the first World War to become a great industry. It is conceivable that the inventive talent of Americans, if fully stimulated, will provide many novel devices and create many new industries which will enable us to win the peace that follows the war. In connection with this important part of the task of the National Patent Planning Commission, the many members of the engineering profession can be of particular assistance.

Optimism Warranted

Difficult and uncertain times are ahead. We must not, however, allow present world conditions to undermine our faith in humanity, in the ability of our own engineering profession to solve difficult problems or in the future of this, the most civilized and humane democratic nation in all history. This great country, which has had for 153 years a good government, the most creative people in the world's history and the rugged idealism which has stood for the noblest and best in human conduct, is bound to demonstrate the superiority of a free, courageous and united people in its struggle against the wrong idealogy of our misguided enemies. Let us pull together so that victory may be assured for the United Nations and let us use our talents as engineers to aid in winning the war quickly and in perfecting a plan for the enhancement of American ideals and American standards in a world at peace.

Elliott Company Awarded Army-Navy "E"

The Jeannette Plant of the Elliott Company was awarded the coveted Army-Navy Production Award on February 5 in recognition of exceptional performance in supplying war material for America's fighting forces.

The Army-Navy "E" pennant was presented by Rear Admiral W. C. Watts, U.S.N. (Ret.) to H. M. Hubbard, President of the Elliott Company, who accepted it in behalf of the workers and management of the plant.

Lt. Col. Thomas H. Eddy, of the Pittsburgh Ordnance District, presented a token Army-Navy "E" pin to William Spicher, employee of the Company for seventeen years, and World War I veteran, signifying that all employees of the Elliott Company's Jeannette Plant are now entitled to wear the "E" insignia.

Before the pennant raising ceremonies Rear Admiral Watts, Col. Eddy, a group of Navy and Army officers, and officials of the Company made an inspection tour of the entire plant.

Dustless Treatment of Coals

The information presented is taken from a report on "The Dustless Treatment of Coals with Calcium Chloride and Other Materials," by Ralph A. Sherman and George W. Land, of Battelle Memorial Institute. It concerns the application of calcium chloride to coals of varying porosity, the permanence of treatment in relation to the amount applied, the effectiveness of mixtures of Clarion extract with calcium chloride, and preliminary data on the problem of corrosion and on the freezeproofing of coal.

TO INSURE that producers of bituminous coal may be able to treat coal properly to reduce the dust in handling, Bituminous Coal Research, Inc., has begun an extensive program of research. The present data on the use of calcium chloride and Clarion extract, a paper-mill liquor, lead to the following tentative conclusions:

1. Based on tests at one week after treatment, calcium chloride satisfactorily reduces the dustiness of domestic stoker coals from seams having inherent or bed moisture contents of 8 per cent or less.
2. Coals of high inherent moisture content, of the order of 18 per cent, are not effectively treated with calcium chloride because of the rapid absorption of the treating material into the coal.
3. The dustiness of coals treated with calcium chloride increases with time of storage because of absorption of the treating material into the pores of the coal, but even after three months of indoor storage, the dustiness of coals having inherent moisture contents of 8 per cent or less is much lower than for the untreated coals.
4. A high relative humidity should be maintained in the coal bin to decrease the dustiness of coal treated with a hygroscopic material such as calcium chloride. To do this the bin should be sealed from the basement to prevent air circulation and to keep the bin cool. Occasional sprinkling of the surface of the coal with water will also be helpful.
5. The rates of application required for effective treatment differ for various coals, but are of the order of 7 to 10 pounds of calcium chloride per ton of coal for coals having inherent moisture contents of 8 per cent or less.
6. The experiments have not shown a conclusive superiority of either method of application of calcium chloride, dry or in solution, but if dry flake calcium chloride is applied to dry coal, the addition of water at the time of treatment is advised to obtain rapid, uniform distribution of the calcium chloride over the coal.
7. The paper-mill liquor, Clarion extract, was not effective by itself in reducing the dustiness of coal, but the application of the rate of 3 gallons per ton of coal of a solution of two parts of the extract with one part of water plus $1^1/_2$ pounds of calcium chloride per gallon of solution was very effective in reducing the dustiness of one coal of 3.2 per cent inherent moisture, Elkhorn seam, and this effectiveness was well maintained after one month's storage.
8. Although iron or steel wet with water will corrode, it will be expected to corrode more when exposed to calcium chloride or other salt solutions. Hence, care must be exercised in washing and painting metal equipment with which these solutions come in contact. Experience shows that, with reasonable care, no serious difficulty will be encountered.
9. Care must be taken that the treating solution is not made with acid mine water or that, if acid water must be used, its acidity is neutralized. Contrary to common belief, calcium chloride solutions, as prepared for coal treatment, are not acid if the water used in their preparation is not acid.
10. Preliminary experiments on the corrosion of screws of residential stokers show that if the stoker is so operated as to produce excessive temperatures, of the order of 300 deg. F or higher, in the coal feed tube, the calcium chloride on coal treated with calcium chloride may be decomposed with the liberation of hydrochloric acid which can attack steel when the acid meets water with which it may combine. The adjustments on the stoker to prevent these high temperatures in the coal feed tube are those that result in the best performance of the stoker.
11. The low freezing points of solutions of calcium chloride make it a desirable material for prevention of freezing of wet-cleaned coal. The difficulties of unloading cars of frozen coal at destination can be avoided when adequate amounts are properly applied.
12. The amount of calcium chloride required will vary with the surface moisture of the coal and the temperature to which it is desired to protect against freezing. For protection of coal containing 2 per cent surface moisture to 20 F, 170 pounds are required per 50-ton car; for a coal of 10 per cent surface moisture to zero F, 1650 pounds are necessary.
13. Application of one-fourth of the total amount on the bottom and sides of the car and the remainder uniformly through the car in the upper half of the car is suggested to avoid loss of the calcium chloride through drainage.

The calcium chloride used was the usual dry flake form containing 70 to 80 per cent $CaCl_2$ bought in the open market in 100-lb bags. The coals selected were of varying porosity, which is roughly indicated by the variations in the inherent moisture of the coal, i.e., 18.4, 8.0, 3.2 and 1.6 per cent, respectively. Applications were made by mixing a weighed amount of the flake calcium chloride with a weighed amount of the coal, and in wet form by spraying the solution of the chemical in water onto a stream of coal falling from a belt. Treated samples of the four coals were stored in bags for periods of one to three months before testing, and prior to testing for two days in a constant humidity room.

The dustiness of coal treated with hygroscopic material will increase as the relative humidity of the atmosphere of storage decreases. The humidity of the coal bin should be kept as high as possible by sealing the bin from the basement. Occasional light sprinkling of the surface of the coal will also help to maintain a high relative humidity in the storage bin.

Decrease in effectiveness of treatment. Data obtained by leaching samples of treated coal in distilled water for 2 hours show clearly the absorption of calcium chloride into even the low-porosity coal. The recovery of 98 per cent from freshly treated coal is a check on the rate of application. The recovery of 56 per cent one week later proves the disappearance, and the recovery of 94 per cent when the same coal was crushed to pass an 8-mesh screen proves definitely that the calcium chloride was in the pores of the coal to be dissolved when water could reach it.

Paper-mill liquor and calcium chloride. Several paper-mill liquors were examined with particular reference to their odor and stickiness. All were found to dry completely when exposed to normal atmospheric conditions. When additions of calcium chloride were made, all but one, Clarion extract, precipitated a sludge. The producers, the Castanea Paper Company, of Lock Haven, Pa., report that they can furnish 150 to 160 tons per day at $10.00 per ton f.o.b. Johnsonburg, Pa., in tank car lots shipped in 8000- and 10,000-gallon cars.

Tests with the mixture of Clarion extract and calcium chloride have been completed on one coal after storage for one month and other tests are under way. The application of 3 gallons per ton ($1^1/_2$ lb of calcium chloride per gallon of solution of two parts of the extract and one part of water) gave acceptably low float and coarse dust indexes at the end of one month's storage.

Corrosion by calcium chloride. Most common metals combine rapidly with dry oxygen when raised to elevated temperatures as, for example, iron at temperatures above 700–800 F. Water will

combine with iron at normal atmospheric temperatures, and because the process is electrolytic, the presence of any salt that increases the electrical conductivity of the solution will increase the rate of corrosion.

Many companies have used calcium chloride for years without serious difficulty from corrosion. Care in washing down metal surfaces exposed to the treating solution, painting the surfaces with chromatic primer or red lead chromate paint should reduce the difficulty to a minimum. The addition of small amounts of chromates or other inhibitors of corrosion is standard practice in the refrigeration industry and may be used in the treatment of coal.

Calcium chloride solutions should not be made with acid mine water; if acid water must be used it should be neutralized by the addition of soda ash or lime. A popular misconception is that calcium chloride solutions are acid in reaction. The data obtained from measurements of solutions normally prepared for application to coal (3 lb of commercial 77 to 80 per cent $CaCl_2$ per gallon) show that the pH value decreased with increase in temperature, but even at 170 F the solutions were distinctly alkaline.

Freezeproofing coal. Because calcium chloride markedly reduces the freezing point of water, wet coal may be loaded in freezing temperatures with the assurance that it will arrive at its destination unfrozen. A minimum point of −60 F is possible with a 41 per cent solution; for common salt it is only −6 F. The freezing point of the commonly used concentration of 3 lb of 77–78 per cent calcium chloride per gallon of solution is −12 F.

To avoid adding enough calcium chloride to lower the freezing point of all the extraneous moisture on wet-cleaned coal, it is suggested that the application be concentrated in the upper half of the car. Application of calcium chloride directly to the bottom and sides of the car is advised to insure that the coal will not be frozen to the metal. Coal freezing to the walls will cause arching even if the inner coal is not frozen.

The following rates (pounds of 77–80 per cent calcium chloride) are suggested per 50-ton car for coal of varying surface moisture content to varying temperatures:

Minimum Temperature, deg. F	Surface Moisture Content, per cent 2	5	10
20	170	425	850
10	250	625	1250
0	330	825	1650

Approximately one-fourth of the total amount should be thrown against the bottom and sides of the car and the remainder applied through the coal in the upper half of the car.

If the coal contains only 1 to 2 per cent surface moisture, solutions of calcium chloride can be applied without great loss or dilutions. Based on 1 per cent surface moisture, solutions of 3 lb per gallon at the rate of 3 gallons per ton, will give a concentration on the coal of 18 per cent which will give protection against freezing to a temperature of 10 F.

Heads Chicago District for C.E.

A. B. Openshaw has been appointed Manager of the Chicago District Sales Office of Combustion Engineering Company, Inc., succeeding James D. Harrison, recently deceased. Mr. Openshaw joined the Company in 1924 and in the interven-

ing period has been engaged in sales work in the Boston, Cincinnati, Pittsburgh and Chicago territories. More recently he was attached to the Hedges-Walsh-Weidner manufacturing division of the Company, as assistant to A. J. Moses, Vice-President and General Manager of that division.

Utilities Make Large Contribution to Scrap

According to an announcement by the Edison Electric Institute, scrap drives and continuous salvage programs of the electric utility companies last year netted twenty-four million pounds of copper for the nation's war needs. This represented approximately ten per cent of the normal annual copper requirements of the electric industry which, in peacetime, is the largest user of this metal. It is estimated that about half this amount will be salvaged during the present year, this being due to the thoroughness of the 1942 scrap collection.

By holding down their own use of copper and other metals to the lowest possible levels, mainly through substitutions and reprocessing, the utilities have been able to release many thousand tons for military purposes.

Historic Building Scrapped

In addition to the copper contributed to the war effort, the utilities salvaged large quantities of other urgently needed materials, such as aluminum, brass, steel, zinc, lead and rubber. Outstanding was the dismantling and scrapping of the historic eight-story Edison Station at Philadelphia, which was erected under the supervision of Thomas A. Edison and was that city's first successful electric plant. Included, besides the building steel, were old boilers, stacks, generating sets, piping valves, pumps, etc.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Adjustable V-Belting

Manheim Manufacturing and Belting Company has issued an 8-page illustrated bulletin featuring its Veelos V-Belt. This is a complete catalog and instruction manual which shows the sequence of operations to take this link-type belt apart with a screw driver, and the necessary steps to couple it without the use of any tools. The method of installing the belt to the drive and a number of typical applications are also shown. Length and weight tables, hp ratings and a price list are also given.

Bibliography on Automatic Stations, 1930–1941

This publication, sponsored by the A.I.E.E. Committee on Automatic Stations, supplements earlier bibliographies on the subject published previously in A.I.E.E. Transactions.

The material is divided into the following sections: General; supervisory and remote control; telemeter and telemetry; automatic and remote-controlled switches and switchgear; automatic features of generating stations using fuels; automatic boiler and combustion control; automatic hydroelectric plants, automatic substations.

The publication is obtainable from A.I.E.E. headquarters, 33 West 39th Street, New York, N. Y., at 25 cents per copy for A.I.E.E. members; 50 cents to non-members. Remittances, payable in New York exchange, should accompany orders.

Proportioning Equipment

The Cochrane Corporation has issued a new bulletin (No. 4009) describing its double displacement proportioning equipment using pH control. The principle of operation is described and illustrated together with applications in connection with hot process softeners and with zeolite softeners. The equipment may be used for acids, corrosive liquids and other clear solutions.

Wartime Engineering

Westinghouse Electric and Manufacturing Company has issued, in place of its annual review of progress in electrical engineering and apparatus, a 32-page bulletin giving a brief account of technical problems presented to a large engineering company, such as Westinghouse, in time of war. This is a very interesting publication covering many wartime topics and illustrated with many photographic halftones.

Welding and Brazing Aluminum

The Aluminum Company of America has issued a new edition of its welding handbook, "Welding and Brazing Alcoa Aluminum." This is a well-written and admirably illustrated 100-page booklet designed to meet the needs of the practical welder. Specific instructions are given concerning the commercially important processes which are: (1) fusion welding, including the use of gas, metal arc, automatic and manual carbon arc, and automatic hydrogen; and (2) electric-resistance welding, which includes spot-, seam-, and butt-flash-welding methods. Three newly developed methods of joining aluminum alloys are also described: furnace brazing, torch brazing and dip brazing. The booklet contains many useful tables and is liberally illustrated with line diagrams and photographic halftones.

EQUIPMENT SALES

as reported by equipment manufacturers to the Department of Commerce, Bureau of the Census

Boiler Sales

Stationary Power Boilers

	1942 Water Tube No.	1942 Water Tube Sq Ft*	1941 Water Tube No.	1941 Water Tube Sq Ft*	1942 Fire Tube No.	1942 Fire Tube Sq Ft	1941 Fire Tube No.	1941 Fire Tube Sq Ft
Jan.....	197	1,590,796	170	968,275	52	59,476	89	123,459
Feb. ...	216	1,467,900	97	847,331	58	83,647	81	104,622
Mar....	268	1,487,505	138	988,037	60	62,679	86	89,324
Apr. ...	422	2,402,579	159	802,993	46	61,054	129	151,636
May...	156	1,243,328	134	850,659	57	83,147	114	154,964
June...	139	847,562	141	743,762	57	74,231	114	134,880
July ...	133	880,420	184	1,184,984	45	53,596	94	121,884
Aug....	113	933,660	113	749,405	26	30,228	91	101,284
Sept. ..	48	378,096	120	843,896	337	275,808	61	63,385
Oct....	151	1,048,117	140	835,912	14	24,611	89	96,740
Nov. ..	48	241,155	117	826,152	21	24,470	47	45,147
Dec....	162	973,214	153	1,036,035	7	11,384	95	87,476
Jan.-Dec. Incl..	2,053	13,494,342	1,660	10,560,941	780	844,331	1,090	1,274,801

* Includes water wall heating surface.

Total steam generating capacity of water tube boilers sold in the period January to December (incl.) 1942, 117,678,000 lb per hr; in 1941, 108,079,000 lb per hr.

†Mechanical Stoker Sales

	1942 Water Tube No.	1942 Water Tube Hp	1941 Water Tube No.	1941 Water Tube Hp	1942 Fire Tube No.	1942 Fire Tube Hp	1941 Fire Tube No.	1941 Fire Tube Hp
Jan...........	87	42,876	77	41,975	154	23,550	94	14,036
Feb...........	131	55,001	60	27,736	185	26,889	117	14,774
Mar...........	84	46,055	69	31,342	212	31,715	146	21,552
Apr...........	102	49,061	75	34,832	313	39,877	147	20,555
May..........	125	44,069	90	43,971	206	33,566	144	19,267
June..........	123	48,267	136	50,896	296	49,760	264	42,619
July..........	131	59,376	113	50,108	297	45,902	290	40,943
Aug...........	94	40,619	96	41,882	295	49,725	391	49,547
Sept.	78	37,081	83	33,663	295	44,910	335	49,559
Oct...........	85	26,633	57	21,269	353	49,575	344	54,027
Nov...........	120	59,799	57	25,645	333	49,799	207	27,375
Dec...........	79	24,140	95	44,080	316	51,947	194	28,149
Jan.-Dec. Incl.	1.239	532,977	1,008	447,399	3,258	497,215	2,673	382,403

† Capacity over 300 lb of coal per hr.

Pulverizer Sales

	1942 Water Tube No. (N)	1942 Water Tube No. (E)	1942 Water Tube Lb Coal/hr	1941 Water Tube No. (N)	1941 Water Tube No. (E)	1941 Water Tube Lb Coal/hr	1942 Fire Tube No. (N)	1942 Fire Tube No. (E)	1942 Fire Tube Lb Coal/hr	1941 Fire Tube No. (N)	1941 Fire Tube No. (E)	1941 Fire Tube Lb Coal/hr
Jan......	*100	3	*1,011,265	39	—	462,990	—	—	—	—	1	1,000
Feb.	21	1	246,520	42	4	734,200	—	—	—	—	—	—
Mar.....	*30	7	*350,970	31	3	739,700	*—	—	*—	—	—	—
Apr.	*46	8	*741,780	14	8	225,740	—	—	—	1	—	2,800
May....	*25	4	*372,682	54	10	777,320	—	—	—	—	4	7,000
June....	24	3	323,500	28	24	523,540	—	—	—	—	1	1,000
July.....	21	11	300,880	57	7	828,640	—	—	—	—	1	600
Aug.....	3	12	*204,460	30	5	456,480	—	—	—	—	1	800
Sept	23	12	488,900	38	2	480,030	—	1	700	—	—	—
Oct......	48	5	*969.570	59	—	764,620	—	—	—	—	—	—
Nov.....	17	9	539,800	38	4	656,630	—	1	1,000	—	—	—
Dec.....	6	12	131,310	40	2	651,780	—	—	—	—	—	—
Jan.-Dec. Incl...	364	87	5,681,637	470	69	7,301,670	—	2	1,700	1	8	13,200

(N)—New Boilers; (E) Existing Boilers. * Revised.

Conversion From Oil to Coal

Despite the fact that the heating season is almost over, the demands for power continue and the ever-increasing demand for shipments of fuel oil overseas continues to place great emphasis on the subject of conversion for installations not yet adapted to coal firing.

All engineers who may be called upon to assist or advise others in conversion problems are afforded the opportunity to get authoritative first-hand information at an A.S.M.E. meeting on Monday, March 22, at 7:30 p.m. in the Auditorium at the Society's headquarters, 29 West 39 Street, New York City. Speakers on the topic "Conversion—Oil to Coal" will be R. M. Hardgrove, of the Babcock and Wilcox Company, and Otto de Lorenzi, of the Combustion Engineering Company. Their presentations will include discussions and illustrations of typical cases of conversion to hand, stoker and pulverized coal firing. H. Weisberg, of the Public Service Electric and Gas Company, Newark, N. J., will act as Chairman.

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